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U.S. Army Armament Research, Development and Engineering Center

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Virtual Employment Test Bed

Operational Research and Systems Analysis to Test Armaments Designs Early in the Life Cycle

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14. ABSTRACT

There is always a desire to gather user test data early in the product development life cycle in order to avoid the larger costs of changing a design later. The DoD has encouraged the use of modeling and simulation as a way of achieving early insight to the capabilities or improvements of a new design. The Virtual Employment Test bed (VETB) allows engineers to test and evaluate material solutions in a realistic combination live/virtual environment, as well as the associated user performance characteristics. This program brings together three current, state-of-the-art, ARDEC capabilities to form a user performance evaluation test bed where ARDEC designs will be evaluated under operational scenarios at any point in the system lifecycle. The Virtual Employment Test Bed (VETB) provides a 180 degree wrap around environment where any ARDEC (and PM) system can be evaluated. VETB provides engineer and user jury feedback, in an operational environment to capture more realistic performance measurements. Once users have completed an exercise, their performance data, such as accuracy and reaction time, will be immediately available. System adjustments can be made and tests rerun rapidly. The VETB offers flexibility and can be altered for specific systems if necessary. While the typical first person shoot simulations are usually used for training, the TBRL utilizes virtual adversaries to conduct testing of the design and function of equipment. The VETB is an integration of several systems that creates a full scale targeting measurement system. The VETB is configured for data collection, including video recording equipment and motion capture cameras and sensors on guns to record trigger pulls. The test bed also includes computer control systems, video recording, motion capture (MOCAP), audio/visual equipment, and flexible integration of stimulus devices; x, y, z location coordinates are captured in real time. This real time information allows the TBRL to test system characteristics. These methods also allow the TBRL to test the impact of platform characteristics on weapon effectiveness, for example slew rate, speed of targeting, rate of fire, etc. This capability is most useful in examining the parameters determining the effectiveness of weapons fire.

15. SUBJECT TERMS

Virtual Environments, Testing and Evaluation, Motion Capture, Gunner Protection Kit, Test Bed, Soldier, Operational Research, Systems Analysis, Armaments Design, Shooting Performance, Target Behavioral Response Laboratory

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Overview

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  - Operational research and systems analysis to test armament designs early in design phase
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- **Gunner Protection Kit (GPK) testing**
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US Army - ARDEC

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ARDEC's Role


RESEARCH


DEVELOPMENT


PRODUCTION


FIELD SUPPORT


DEMILITARIZATION

Advanced Weapons:
Line of sight/beyond line of sight fire; non line of sight fire; scalable effects; non-lethal; directed energy; autonomous weapons

Ammunition:
Small, medium, large caliber; propellants; explosives; pyrotechnics; warheads; insensitive munitions; logistics; packaging; fuzes; environmental technologies and explosive ordnance disposal

Fire Control:
Battlefield digitization; embedded system software; aero ballistics and telemetry

ARDEC provides the technology for over 90% of the Army's lethality and a significant amount of support for other services' lethality

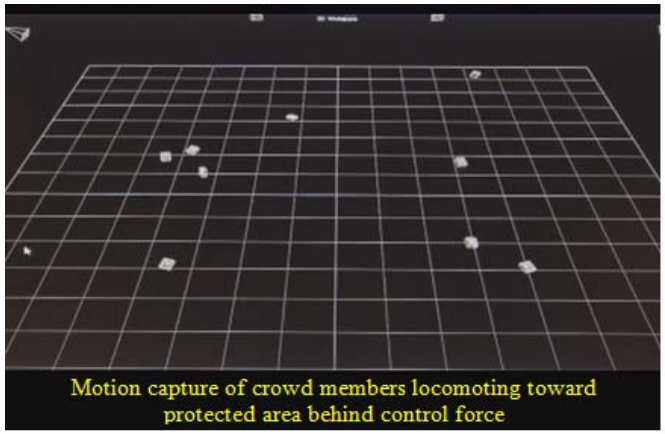
Introduction

Operational Research and Systems Analysis to Test Armament Designs Early in Design Phase

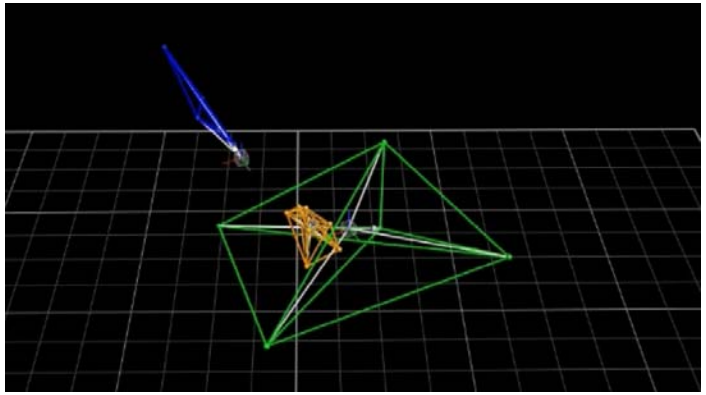
- The U.S. Army Armament Research, Development and Engineering Command (ARDEC) seeks to improve Soldier lethality, survivability, and mobility
- Modeling and Simulation offers capability to conduct trade-off analysis early in design phase
- Quantitative performance data to support project development and acquisition decisions
- Materiel evaluation will help drive towards an optimal system

Introduction

Performance Evaluation at Target Behavioral Response Lab



Performance of Non-Lethal Weapons against targets



Performance of individual Soldiers using ARDEC systems

The Virtual Employment Test Bed

Goals for the Virtual Employment Test Bed (VETB)

- To leverage the tools and techniques developed at the Army's Target Behavioral Response Laboratory to investigate ARDEC armament systems
- To leverage the capabilities of the ARDEC Gaming and Interactive Technologies Multimedia (GITM) group
- Create a immersive synthetic test environment sensitive enough to evaluate proposed armament solutions before we "bend metal"
- To bring in the system's user to not just give feedback, but to provide system performance data for the prototype solutions
- Create a test bed that can be used for the evaluation of mounted and dismounted armament systems

Introduction

- **Movie**

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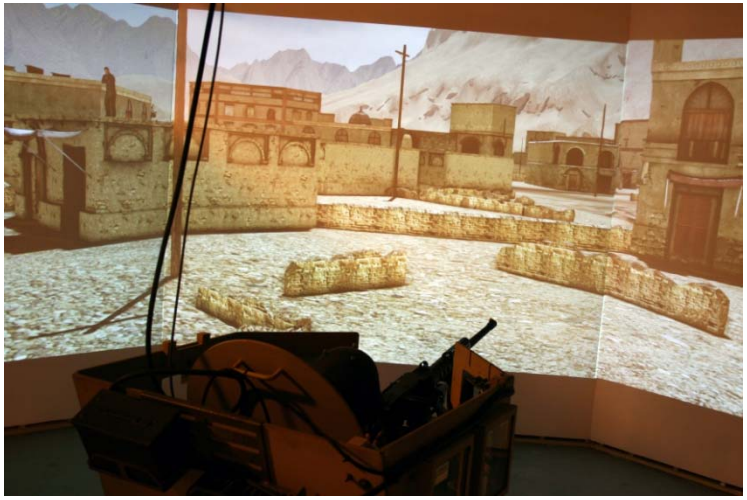
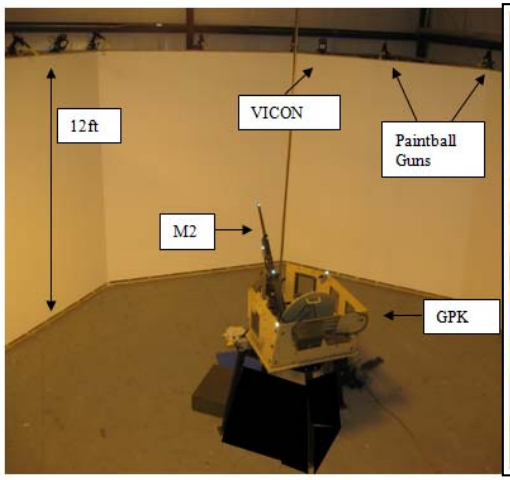
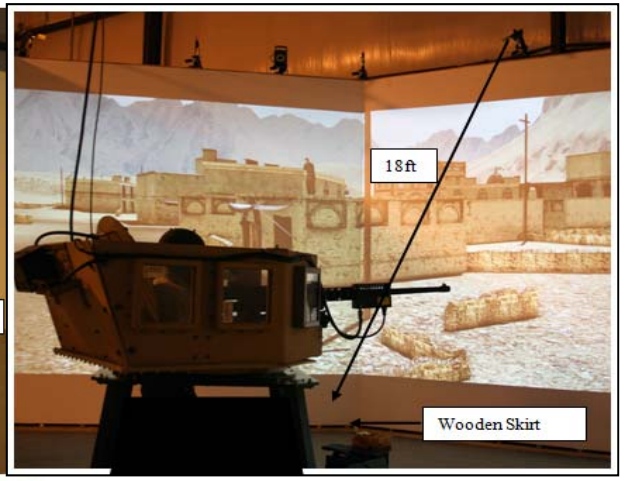


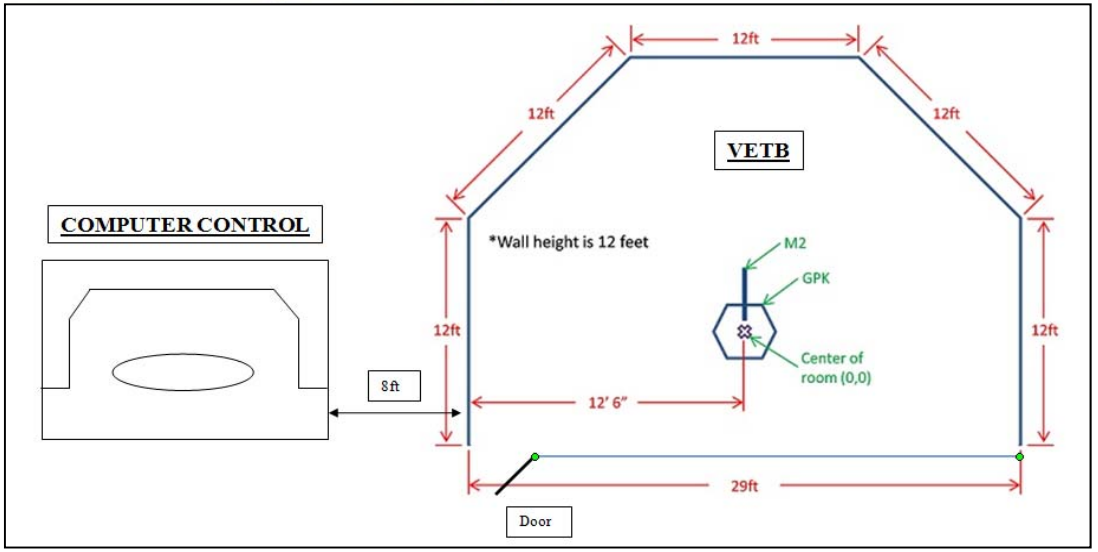
The Virtual Employment Test Bed

Configuration

- Current configuration is 5 screens, each 12 ft wide by 12 tall
- Stationary Gunner Protection Kit is place in the center of the test bed
- Virtual environment is projected onto the screen using 5 projectors
- Simulated return fire comes from paintball guns located on top of the walls







The Virtual Employment Test Bed

Instrumentation

- Unreal gaming engine is used to create the simulated environment
- Vicon motion capture system captures movement inside the test bed
- Custom LabVIEW programs and subroutines used for
  - Acquiring and processing Vicon motion capture data used to determine position and orientation of a Soldier's head, turret and the M2 machine gun
  - Controlling and acquiring user/weapon data from the M2 simulation machine gun
  - Controlling paintball guns used to fire at the GPK during an experimental run
  - Sending and receiving TCP communications to and from computer that runs the virtual environment

http://www.army.mil/article/94753

TCP/IP (Transmission Control Protocol/Internet Protocol)

Gunner Protection Kit Testing

Test Design

- A task was configured to stress the system in terms of the mechanics of targeting
- A procedure that is capable of stressing the system required a spectrum of movements from right to left (slewing) as well as movements up and down
- Target locations were positioned to require sweeps of approximately 45, 90, and 180 degrees, from the right to the left and from the left to the right and from an upper position to a lower position
- Targets appeared in a pre-determined sequence so that all the spectrums of sweeps and locations were presented in a fixed order
- Only one target was presented at a time and the next target did not appear until the previous target had been successfully terminated
- When the gun was fired, the virtual environment created a virtual .50 caliber bullet with a muzzle velocity of approximately 3000ft/s

Gunner Protection Kit Testing

Test Design

- Experiment 1 gathered performance data on current GPK configuration
- Experiment 2 gathered performance data on GPK without side windows
- Data recorded by the system included head orientation, gun and turret location/orientation, trigger pulls, target hits and target termination
- Metrics generated
  - Soldiers speed of recognition of new target
  - Speed of turret placement
  - Speed of gun barrel placement
  - Speed of target termination

Gunner Protection Kit Testing

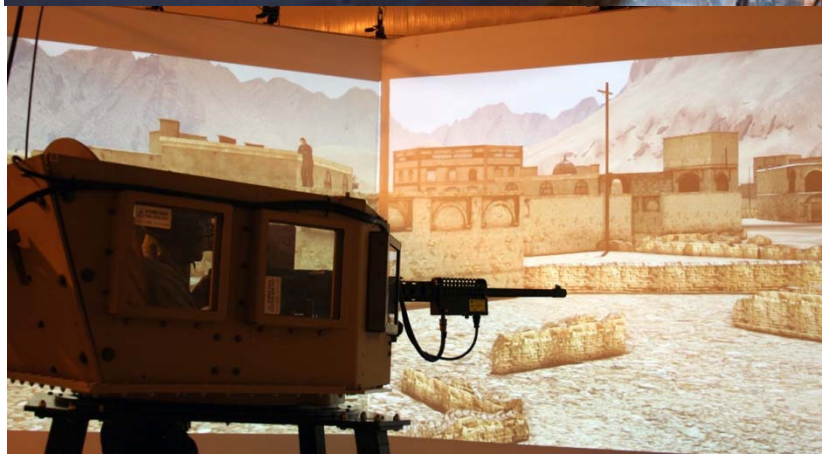
Soldier Recruitment

- The two separate experiments conducted each required 12 Soldiers
- 24 Soldiers were recruited through the U.S. Army Forces Command (FORSCOM)
- Requirements for Soldier experience included
  - Infantry/Mounted, Armor/Cavalry, Combat Engineers, Field Artillery Cannon Crewmember, or MP duty assignment
  - Currently M2 .50 Caliber Machine Gun qualified, experience as a gunner on vehicles that were fitted with the Gunner Protection Kit
  - Recently returned from theater (Afghanistan or Iraq) within one year
  - While in theater (Afghanistan or Iraq) active performance of duties in any mounted operation (e.g. Patrol, Route Security, Combat Logistics Patrol, etc.)

Gunner Protection Kit Testing

Test Day

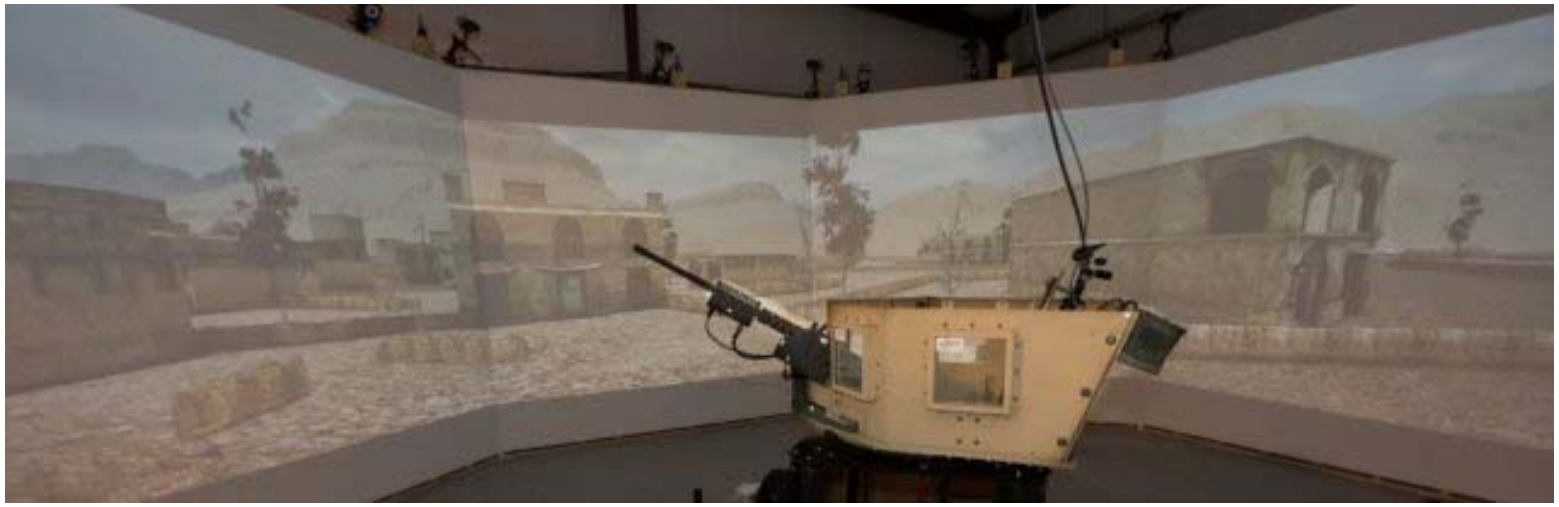
- Soldiers Reported to the Target Behavioral Response Lab for testing
- Soldiers were given a pre-mission brief
- Soldiers were placed in the GPK and asked to perform to the best of their abilities
- Virtual scenario starts in the desert hills where the convoy makes it's way to a building in the nearby town
- Once the vehicle gets to the building the Soldier is engaged in fire fights
- Targets were placed in a courtyard area surrounded by buildings that offered enemy shooters positions above ground level and at ground level



Gunner Protection Kit Testing

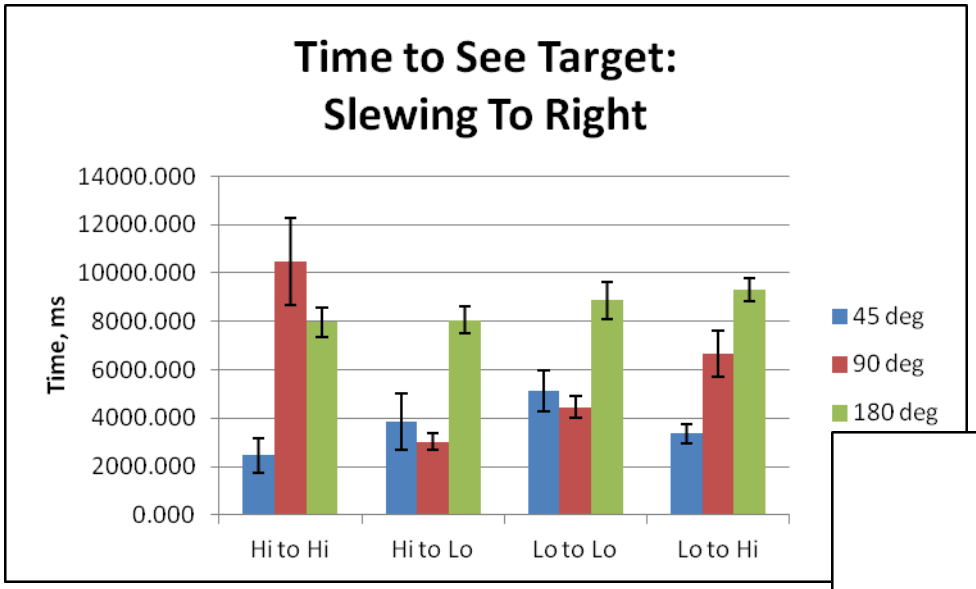
Analysis – Primary Questions

- How fast does the system configuration allow the user to recognize a new target?
- How fast can the gun be placed on the target?
- How fast can the target be shot?
- How fast can the target be terminated?

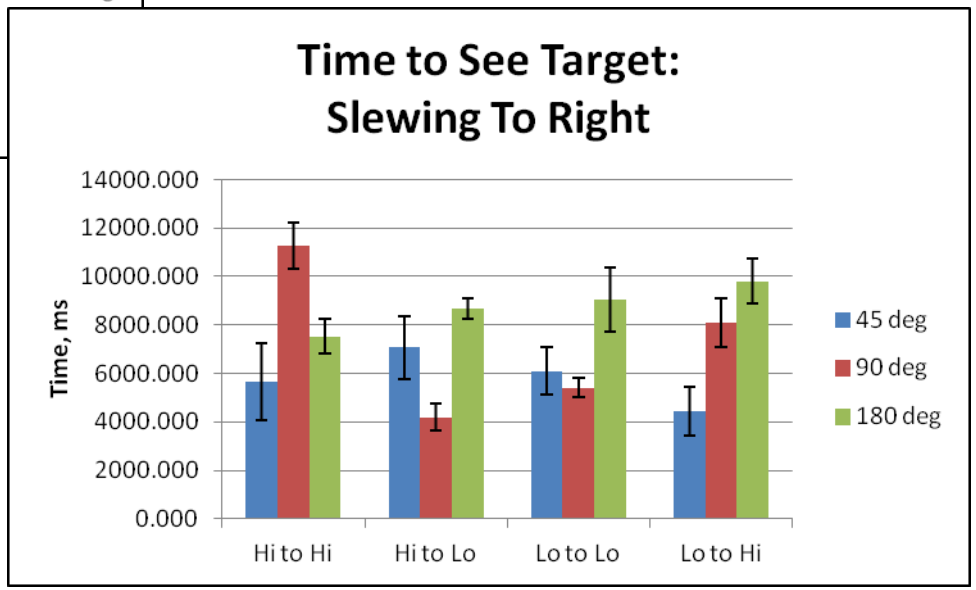


Results

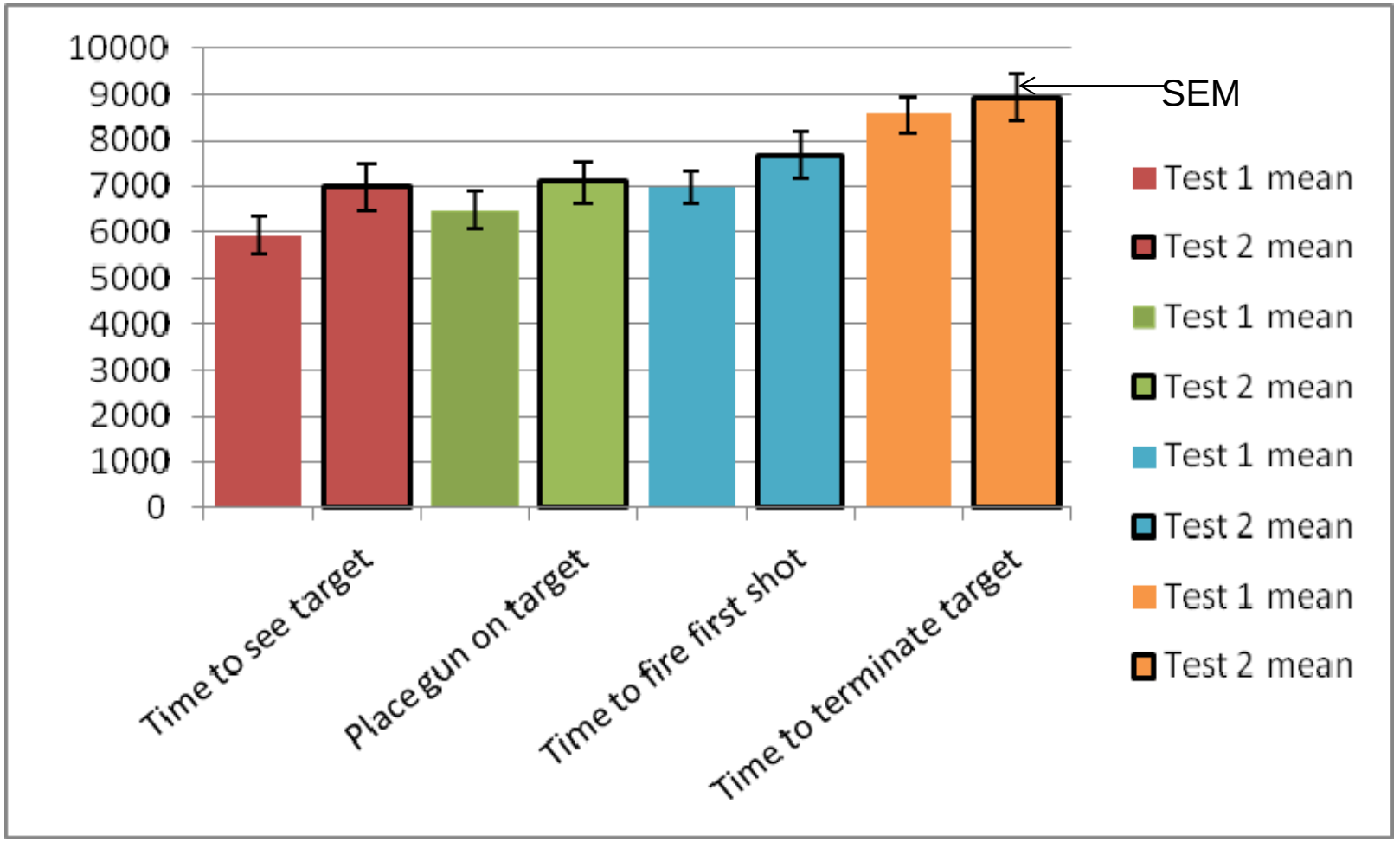
Experiment 1



Experiment 2



Results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5000
4000
3000
2000
1000
0
SEM
Test 1 mean
Test 2 mean
Test 1 mean
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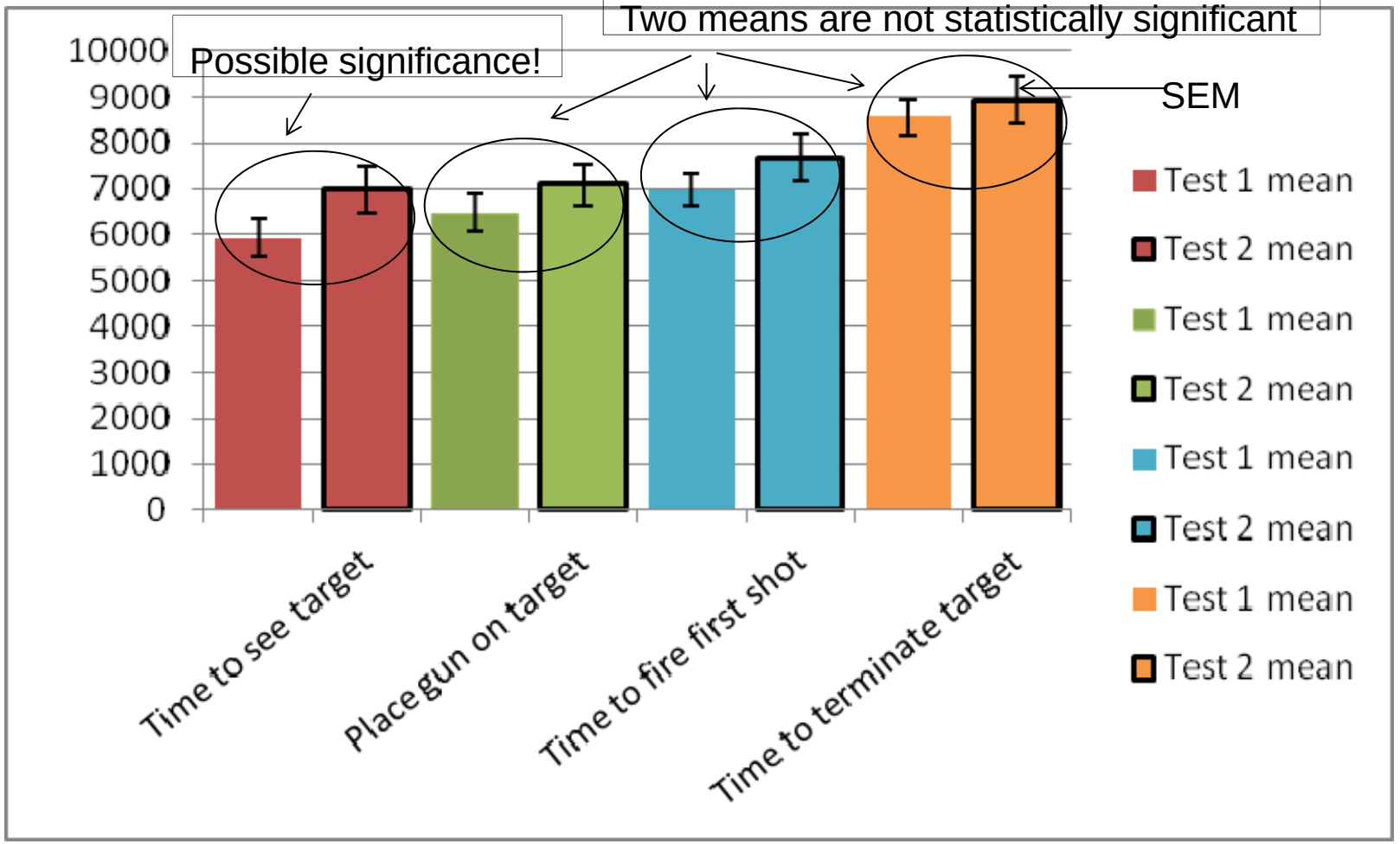
Test 1 mean
Test 2 mean
Test 1 mean
Test 2 mean
Time to see target
Place gun on target
Time to fire first shot
Time to terminate target

Results


Two means are not statistically significant
Possible significance!
SEM
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9000
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7000
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Test 1 mean
Test 2 mean
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Test 1 mean
Test 2 mean
Test 1 mean
Test 2 mean
Time to see target
Place gun on target
Time to fire first shot
Time to terminate target

Conclusion

- As the Army continues to look for new ways to conduct operational research and systems analysis earlier in the design phase ARDEC's Virtual Employment Test Bed has shown the ability to provide valuable data on systems performance in a simulated environment
- The initial testing on the Gunner Protection Kit has shown enough promise that the program manager has selected the VETB as the configuration test environment for the next Objective Gunner Protection Kit (OGPK) design

Summary

- The VETB has shown the capability to gather lethality, survivability, and mobility data on armaments designs early in the design phase
- The initial Gunner Protection Kit project has produced quantitative performance data to support project development and acquisition decisions
- Use of Modeling and Simulation offers the capability to conduct trade-off analysis early in design phase
- Materiel evaluation in this immersive synthetic test environment will help drive towards an optimal system

Questions?

US Army - Target Behavioral Response Lab

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BACKUP SLIDES

Target Behavioral Response Laboratory
MORSS Presentations

- Virtual Employment Test Bed: Operational Research and Systems Analysis to Test Armaments Designs Early in the Life Cycle
- Method and Process for the Creation of modeling and Simulation Tools for Human Crowd Behavior
- Squad Modeling and Simulation for Analysis of Materiel and Personnel Solutions
- The Squad Performance Test Bed
- Crowd Characteristics and Management with Non-Lethal Weapons: A Soldier Survey
- Effectiveness Testing and Evaluation of Non-lethal Weapons for Crowd Management
- Effects of Control Force Number, Threat, And Weapon Type on Crowd Behavior